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COMPARISON OF THE GALVANIC SKIN RESPONSE TO NON-SIGNAL AND SIGNAL STIMULI IN NORMAL AND RETARDED CHILDREN

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled COMPARISON OF THE GALVANIC SKIN RESPONSE TO NON-SIGNAL AND SIGNAL STIMULI IN NORMAL AND RETARDED CHILDREN submitted by Wayne M. Milner in partial fulfilment of the requirements for the degree of Master of Education.

ABSTRACT

The galvanic skin responses of 30 educable mentally retarded and 30 normal children, nine to twelve years of age, were compared to determine if differences exist in their orienting behavior to a variety of stimuli. The galvanic skin response, a component of the orientation reaction, was examined under four task conditions, namely, a non-signal condition, consisting of tone stimuli and signal conditions consisting of verbal auditory stimuli, verbal visual stimuli, and tone stimuli.

The results indicated that normal children demonstrated a greater phasic orienting response for non-signal stimuli than educable mentally retarded children. Educable mentally retarded children had a greater phasic response for verbal visual stimuli than normal children. Educable mentally retarded children also maintained a greater tonic orienting response over the verbal auditory and visual stimuli than did normal children. Normal children elicited a greater galvanic skin response to non signal stimuli than to signal stimuli. No significant response differentiation was recorded with the educable mentally retarded children.

The differences generally reported between normal and retarded children were not consistently found herein. The stimulus conditions and task order were considered to be more relevant in the present study.

It was suggested that research be conducted among different levels of mental retardation particularly centered upon their autonomic

activity. Variables which are felt to contribute to the multi-dimensionality of arousal should also be investigated.

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CHAPTER I

INTRODUCTION

The present study is an investigation of possible differences in a component of the orientation reaction between normal and educable mentally retarded children. Specifically, the research examined the galvanic skin response component of the orientation reaction to a selection of non-signal and signal, auditory and visual stimuli.

The occurrence of the orientation reaction was first recognized by Pavlov and his students early in the twentieth century. Western as well as Soviet researchers have since directed their efforts toward the study of this phenomenon (Berlyne, 1960; Luria, 1963a; Lynn, 1966; Maltzman & Raskin, 1965; and Sokolov, 1963; 1966). The reaction is comprised of a number of components including skeletal responses such as head and eye movements, electroencephalogram, together with the autonomic responses of change in heart rate and the galvanic skin response. This system of responses appears to have the effects of facilitating stimulus reception and response to stimulation.

It has been noted that a change in the galvanic skin response comprises one component of the orientation reaction. The reliability of the galvanic skin response as a component of the orientation reaction has been widely supported (e.g., Claussen & Karrer, 1968). This component has been examined in studies of habituation of the orientation reaction (Leavy & Geer, 1967; McCubbin & Katkin, 1968; O'Gorman, Mangan & Gowen, 1970), studies of initial response (Korn &

Moyer, 1968; Lobb, 1970), and of response magnitude (Berkson, 1961; Kaplan, 1970; Wolfensberger & O'Connor, 1965).

Investigation of differences in components of the orientation reaction is essential to the understanding of the construct itself, but of particular educational and practical importance are reaction differences between subpopulations. Two subpopulations of primary educational interest are functionally retarded and normal children. Differences in the orientation reaction of normals and retardates have been reported by several investigators, (Berkson, 1961; Karrer, 1966; Luria, 1963b; with an absent or diminshed orientation reaction to certain stimuli commonly noted among retardates. However, comparison of the orientation reaction under varying stimulus conditions and with a wide sampling of educationally relevant subgroups is still required.

Of particular interest to the educator is the group of children who are often identified as functionally retarded. This subpopulation probably comprises greater absolute numbers that does that group of children for whom there is known organic involvement. If one assumes, as do many investigators, that the orientation reaction is in some ways related to what is loosely referred to as attention, then it seems important that the functioning of the components of the reaction be thoroughly examined with this subpopulation in mind.

The current investigation employs galvanic skin response measures of amplitude and conductance change in examining the galvanic skin response of normal and functionally retarded children to a

variety of stimulus conditions.

CHAPTER II

REVIEW OF RELATED LITERATURE

The orientation reaction appears to prepare the organism for both reception of stimulation and response to stimulation. The galvanic skin response is one component of the orientation reaction and has been identified and confirmed as such in the literature. Karrer (1966) suggests that studies of autonomic activity in functionally retarded children have been limited due to the tendency to include this subgroup with other defectives. To the author's knowledge, no specific investigation has been conducted on the tonic component of the orientation reaction between normal and functionally retarded children. Furthermore, there remains the need to apply the investigation of individual differences in the orienting response to a broader variety of stimuli and especially to such stimuli as might be held to have some educational relevance.

Elicitation of the orienting response

Unexpected stimulus change, including the presentation, modification or termination of a stimulus has been held to be a fundamental condition for eliciting of a component of the orientation reaction (Berlyne, 1960; Sokolov, 1963; Stern, 1968). Berlyne has also referred to the importance of such collative stimulus properties as surprise, conflict, uncertainty and incongruity (Berlyne, 1963; Berlyne & McDonnell, 1965) as conditions which may elicit the reaction.

More recently, O'Gorman, Mangan & Gowen (1970) found that

subjects habituating rapidly to an initial stimulus were less likely to show return of the orientation reaction to continued stimulus change.

The substance of a number of papers (Jeffery, 1968; Leavy & Geer, 1967; McCubbin & Katkin, 1968; and O'Gorman, Mangan & Gowen, 1970), has been directed toward the work of Sokolov who has become a noted Soviet investigator of the orientation reaction. The results generally indicate that any stimulus does not alone elicit a reaction; it must be accompanied by the perception of stimulus change.

Galvanic skin response and mental retardation

A growing body of research evidence may be cited to show that the functioning of the galvanic skin response component of the orientation reaction may be different, under some conditions, in mentally retarded as compared with normal subjects. Luria (1963, p.103) states that "in a significant number of cases, stimuli of low or medium intensity which always evoke the orientation reaction in normal children, are not accompanied by such reactions in (retardates)".

Berkson (1961), has concluded that mentally deficient children respond less intensely and for a less period of time to short duration auditory or visual stimuli than do normals. Karrer and Claussen (1964) found significantly shorter latency and shorter time to peak response in retardates on galvanic skin response than with normals. Wolfensberger and O'Connor (1965) have reported that latency to response onset did not significantly differ for a group of young adult nonorganic defectives compared to that of a normal group for low and high intense

light stimuli.

Conflicting evidence is provided in galvanic skin response latency for normal and retarded groups. However recent literature indicates that retardates do not show an appreciably slower rate of galvanic skin response habituation than do normals (Claussen & Karrer, 1968; Fenz & McCabe, 1971; Lobb, 1970; Pilgrim, Miller & Cobb, 1970; Wolfensberger & O'Connor, 1965). If there is not a deficit in rate of habituation between normals and retardates then the investigation of other galvanic skin response measures is warranted.

It is interpreted from the literature that galvanic skin response amplitude measures may contribute to differentiate the above mentioned subgroups. Fenz & McCabe (1971) point out that nonorganic institutionalized retarded children have a greater amplitude response to the first in a series of auditory stimuli than do normal children. Lobb (1970) has found differences between institutionalized retarded adults and normal adults, with normals having greater amplitudes than retardates in the early trials of the second day. Making an orienting response of high galvanic skin response amplitude has been shown to affect learning involving semantic conditioning of the galvanic skin response (Maltzman & Raskin, 1965).

It appears then, that response amplitude measures discriminate, to some degree, the galvanic skin responses of normal and mentally retarded children. With the functionally retarded child there is a learning deficit which might be due in part to a deficit in their initial orienting behaviour. Differences between normal and retarded

groups have been noted with respect to some of the galvanic skin response measures, but there has been too little attention given to possible distinctions between functionally retarded children and other classes of defectives. The need for investigation of educable mentally retarded children who comprise a relatively great number in our schools is apparent.

Tonic and phasic aspects

Some writers have distinguished between so-called phasic and tonic aspects of the orientation reaction. Berlyne (1960) and Sokolov (1963; 1966) indicate that the phasic constituent of the orientation reaction is a rapid, short lived physiological change in response to stimulation. The tonic reaction is a slower and longer lasting response. It is slow in its development and extends over a longer period of time than the phasic response.

Most studies of orientation have investigated the phasic reaction. Neglect of the tonic response may be due in part to difficulties in distinguishing it from what western psychologists commonly refer to as arousal. Indeed there is likely considerable redundancy between the tonic orientation reaction on one hand and arousal on the other. Yet Sokolov (1966, p. 343) has argued that the tonic reaction is delimited from the more general case of arousal in referring only to those cases of arousal increase which are functionally related to stimulus change. The arousal increase is said to be independent of the direction of stimulus change.

In the current study, the tonic response will not be

operationally distinguishable from arousal. The temporal characteristics of the arousal change, however, will be carefully related to the condition of stimulus change, thereby ruling out some categories of arousal change which could not be a function of the tonic response.

Since there has been little attempt to investigate the tonic response on an experimental basis, any light which may be shed on this phenomenon must be drawn from work on arousal. The arousal concept has often been understood as representing a rather unitary state of organism activation, but some recent views (Berlyne, 1967; Lacey, 1967; Taylor & Epstein, 1967) have argued that ultimately we might discover that multidimensionality is more characteristic of arousal responses. In any event, the galvanic skin response alone would need to be interpreted cautiously as an index of arousal. What does seem clear however, is that levels of arousal are probably related to some performance variables.

One study which does offer a little support for Sokolov's notion of the tonic response was conducted by Germana and Chernault (1968). In an investigation of the galvanic skin responses they specifically noted what they called a tonic response where signal stimuli were provided. No such tonic response was identified for non-signal stimuli.

The present investigation employed the verbal signal stimuli of auditory and visual anagrams in the analysis of the tonic aspect of the orientation reaction in normal and educable mentally retarded children.

Galvanic skin response and verbal instructions

Soviet writers in particular have observed that orientation reactions may occur in response to both non-signal and signal stimuli. Non-signal stimuli are those stimuli to which an orientation reaction has not been previously conditioned or for which prior instruction, linking stimulus and response, is absent. Signal stimuli, on the other hand, are those stimuli which, whether through prior instructions or through earlier conditioning, reliably evoke an acquired reaction. It is widely noted that the orientation reaction habituates more readily to non-signal stimuli than to signal stimuli.

Korn & Moyer (1968) have shown that with university students the instruction to "pay attention" produced larger galvanic skin response amplitude to the first of each of two sets of tones than tones without such verbal instruction. Luria and Vinogradova (1963) suggest that the orientation reaction is not as well maintained for retardates through the use of verbal instructions (signal stimuli) as it is for normals. Denny argues that "when the mentally retarded are sufficiently well instructed or guided, as under intentional learning conditions, they often do not show a learning deficit" (Denny, 1966, p. 5). This observation seems to be consistent with those of Zeaman and House (1963) and others who have argues that a variable contributing to the seeming difficulty in the learning of retardates has more to do with attention than with associative factors per se. It becomes evident that signal stimuli do enhance the orientation reaction for both normal and retarded groups. The

present study aims to explore this postulate with respect to a number of categories of signal stimuli.

General statement of the problem

The purpose of the current study is to examine possible differences in the orienting responses, as manifest through the galvanic skin response, between normal and those educable mentally retarded children who comprise a large proportion of the students found in special or opportunity classrooms. Differences between the groups in galvanic skin response are compared for both non-signal and a range of signal stimuli. The signal stimuli include verbal and non-verbal and both auditory and visual stimuli. Lastly comparisons between groups in a supposed tonic response during problem solving is undertaken.

CHAPTER III

DEFINITIONS AND HYPOTHESES

General Terms

Orientation reaction. A constellation of responses in the whole body involving sense organs, skeletal muscles, electroencephalogram and the autonomic system. The reaction occurs in response to the presentation, modification or termination of stimuli. It is understood that the reaction facilitates the perception of and the response to stimulation.

Component of the orientation reaction. Any one constituent of the response constellation which comprises the orientation reaction (e.g., galvanic skin response, change in heart rate, eye movements).

Phasic orienting response. A relatively rapidly induced and short lasting change in a component of the orientation reaction.

Tonic orienting response. A change in a component of the orientation reaction which extends over a longer period of time than the phasic reaction. Unlike general changes in arousal, the tonic response is independent of the direction of the eliciting stimulus change.

Non-signal stimuli. Neutral stimuli to which no behavioral associates have been conditioned and which also lack verbal instructions

linking stimulus and response.

Signal stimuli. Stimuli which are conditioned signals for a specific acquired action. Stimuli obtain signal significance through experience or through the provision of verbal instructions relating stimulus and response.

Galvanic Skin Response Measures

Amplitude. Maximum change in natural logarithm conductance within the one to three second period immediately following the stimulus onset. This measure was taken to both the response to the first of a series of stimuli, and also as the mean response to a series of stimuli.

Conductance change. Difference between mean logarithm (natural) conductance observed at half second intervals within two distinct three second periods. In the study, the measures were taken for the three second period immediately preceding stimulus onset and for the three second period immediately preceding stimulus termination. The measure was taken to the first stimulus within a series and as a mean response to the series.

Hypotheses

Rationale. Luria (1963) states that normal children show orienting responses of greater magnitude than do retarded children to stimuli of low or moderate intensity. Although not scaled, the

stimuli of the present study are regarded as moderately intense. Fenz and McCabe (1971) support Luria as they reveal that the average galvanic skin response to 70 db tones was greater for normals than for retardates but retardates responded more strongly than normals to 100 db tones. Adult retardates have shown a greater mean response strength than normals on amplitude and duration measures with varying light stimuli (Wolfensberger et al, 1965). However, Pilgrim et al (1970) have found no significant differences between normal and non-organic children in latency, amplitude or duration with a series of light stimuli. In the present study a variety of stimuli, signal and non-signal, verbal and non-verbal, auditory and visual, are supplied to examine the generality of the observations of Luria, and Fenz and McCabe.

<u>Hypothesis 1.1.</u> Normal children will show a greater galvanic skin response amplitude than educable mentally retarded children to the initial stimulus within each stimulus series across all task (stimulus) conditions.

<u>Hypothesis 1.2.</u> Normal children will show a greater mean galvanic skin response amplitude than educable mentally retarded children to all stimuli within a stimulus series across all tasks conditions.

<u>Rationale</u>. A distinction between non-signal and signal stimuli is made by Sokolov (1963) and Lynn (1966). Signal stimuli evoke an acquired reaction whether through conditioning or through prior verbal

instructions. Non-signal stimuli are classified as indifferent; they are neutral stimuli in that no association either through conditioning or prior verbal instruction has been made between stimulus and response. Luria and Vinogradova (1963) have found that the orientation reaction is not maintained as well in retardates, as in normals, under verbal instructions. Nevertheless, verbal instructions enhance learning for retarded children (Denny, 1966). Instructions to "pay attention" produce larger galvanic skin responses to each of the first tones within a set, (Korn & Moyer, 1968), than do tones without this instruction. Signal stimuli in the current study should produce a greater galvanic skin response than non-signal stimuli, for samples from each subpopulation.

> <u>Hypothesis 2.1.</u> Normal and educable mentally retarded children will have a greater initial amplitude galvanic skin response for all signal stimuli conditions than for the non-signal condition.

> <u>Hypothesis 2.2.</u> Normal and educable mentally retarded children will have a greater mean amplitude galvanic skin response for the signal stimuli conditions than for the non-signal condition.

<u>Rationale</u>. Berlyne (1960) and Sokolov (1963, 1966) distinguish between the phasic and the tonic aspects of the orientation reaction. The tonic response extends over a longer period of time than the phasic reaction and seems comparable in some respects to the arousal reaction discussed in western literature. Since little investigation

of normal - retarded differences in conductance change, as defined in this study, have been made, no directional differences with respect to group or task effects are hypothesized.

<u>Hypothesis 3.1.</u> Normal children will not differ significantly from educable mentally retarded children on the tonic measure of initial conductance change.

<u>Hypothesis 3.2.</u> Normal children will not differ significantly from educable mentally retarded children on the tonic response measure of mean conductance change.

CHAPTER IV

METHOD

Subjects

The sample consisted of eighty students, thirty-seven normal and forty-three educable mentally retarded children within the chronological age range of nine to twelve years.

The children within the educable mentally retarded group are defined as those children who are without known organic defects and/or severe emotional problems, having I.Q. scores between 50 and 80 on the Wechsler Intelligence Scale for Children. Normal children are defined as those who are presently functioning within their appropriate age-grade level. Descriptive information of the subjects is provided in Table 1.

The subjects were selected from classrooms within the Edmonton Public School System, normal subjects being from the regular classroom and educable mentally retarded children from opportunity or special classes. Children whose school records revealed sensory, emotional or organic deviations, or medically identified skin conditions were excluded from the sample. Eight retarded and three normal subjects were later discarded from the sample due to some artifactual or unscorable responses relating to either motor movement or failure in operation of the apparatus. The records of a further five educable mentally retarded and four normal children were randomly eliminated from the sample to obtain the target of thirty subjects in

TABLE 1

DESCRIPTIVE CHARACTERISTICS OF THE GROUPS

		CA (yr-mo)		IQ	
Groups	N	Mean	SD	Mean	SD
Normals	30	11-2	0-11	117	10.392
Retardates	30	10-6	1-10	69	8.944

Groups	N	Males	Females
Normals	30	20	10
Retardates	30	16	14

each group.

Apparatus

Galvanic Skin Response measures were obtained via a Grass model 5 polygraph with a 5E DC driver amplifier and a 5 P1 low-level DC preamplifier. Zinc electrodes were utilized according to Lykken (1959). The active electrode comprised a one-quarter inch solid zinc cylinder inserted in a lucite housing, placed on the central whirl on the distal phalange of the left thumb implementing Lykken's (1959) method for corn pad attachment. The inactive electrode comprised a three-quarter inch diameter zinc cylinder fitted below the flange on a lucite housing, so as to form a shallow cup suitable for receiving the electrode. The inactive electrode was attached to a slightly sanded area of the skin on the left forearm approximately two inches above the wrist. Zinc sulphate with a cornstarch base served as the electrolyte (Edelberg and Birch, 1962).

Task instructions and auditory stimuli were presented by means of a binaural headset integrated with a Sony tape recorder (model TC-777-45) and incorporated amplifier (model 1120). White noise was fed through the amplifier circuit from a Marietta generator (model 24-21B) during tasks, to control for any distracting auditory stimuli. Visual task stimuli were presented on 7.8 x 11 inch cards with a viewing area of 7.8 x 7.8 inches and a viewing distance of approximately 24 inches.

Description of tasks and stimulus materials

The following stimulus materials were involved in the

experimental tasks. Instructions for all tasks are reported in Appendix A.

Task 1. Five pure tones at 72 db, and at a frequency of 700 cps were presented as non-signal stimuli at random intervals within the range of 12 to 30 seconds, with a mean interval of 20 seconds. Irregular intervals between successive stimulus presentation were employed to minimize habituation of the galvanic skin response within the task.

Task 2. The word "ready" was provided as an alerting signal stimulus preceding each of four, three letter anagram problems (see Appendix B). Both the "ready" signal and the anagram problems themselves were presented auditorily via magnetic tape and the binaural headset. Each letter of an anagram problem was presented at an approximate interval of 1.5 seconds. A time limit of 30 seconds was allotted for problem solution after the presentation of the third letter of the anagram.

Task 3. This task was the same as for task two. However, the signal stimulus "ready" and the anagram problems were visually presented in randomized order on 7.8 x 11 inch cards via a viewing stage. The letters of the anagrams were three-eighths of an inch in height and one thirty-second of an inch in width. The letters were inscribed in Indian ink on a white background in a pyramid fashion.

Task 4. The final task paralleled task one, except that the tones served as a signal for an imagined button press response in this task.

Tasks one and four were presented in the above order to minimize habituation across tasks and were not counterbalanced due to the nature of the tone stimuli within each task (non-signal vs signal). The order of presentation of tasks two and three, auditory and visual signal stimuli, was randomly alternated.

The concern of this study was to compare galvanic skin responses between normal and educable mentally retarded children over a variety of stimulus conditions. The selection of non-signal and signal stimuli, including both auditory and visual, and verbal and non-verbal stimuli, provided for a range of comparisons. In task one the tones were presented as non-signal stimuli, that is without instructions to respond to the stimuli in any way. Tasks two and three were signal stimuli in that they possessed presumably, a conditioned alerting response to the verbal signals "ready" (auditory) and "ready" (visual), presented before each anagram. Task four was also of signal value since it was associated with prior verbal instructions of "think of pressin g the button" each time the subject heard the tone.

The auditory and visual anagram tasks were assumed to possess comparable attributes except with respect to stimulation of different sensory modalities. The phasic response was measured to the "ready" signal preceding both the visual and auditory anagrams. The tonic response or arousal reaction was taken to the anagram tasks themselves

as they provided a problem solving situation in which arousal could be expected to be more prevelant than to simple stimuli.

Description of response measures

For task one, galvanic skin responses were measured as maximum change in logarithm conductance within the one to three second period immediately following stimulus (tone) presentation. On tasks two and three, the same procedure was conducted except that scores were obtained on the response to the "ready" signal preceeding the actual anagram. The scoring of the responses on task 4 was identical to that of task one. Amplitude scores were measured for the first stimulus within a series and the mean response calculated across trials. The tonic response of conductance change was scored as the difference between mean logarithm (natural) conductance observed at half-second intervals within two distinct three second periods. In the study, the measures were taken for the three second period immediately preceding stimulus onset and for the three second period immediately preceding problem termination. Again both initial and mean responses were calculated. If the anagram was solved within a thirty second interval the subject would report his answer to the experimenter. If the problem was not solved, after a thirty second time limit (commencing with the provision of the final letter of the anagram) the trial was concluded.

Various measures of the galvanic skin response appear in the literature. Woodworth (1954), Darrow (1964), Martin (1964), and

Montagu and Coles (1966), provide a rationale for the use of change in logarithm conductance as an appropriate measure. Basically, the measure is used to accommodate the law of initial values and to provide values which will tend to satisfy the assumptions underlying statistical treatments, specifically analysis of variance.

Procedure

The subjects were transported to the Education Building at the University of Alberta by taxi. The male experimenter and a female assistant introduced each subject to the apparatus in the experimental room and the galvanic skin response electrodes were explained and applied. A ten minute adaptation period was provided. All subjects were given an opportunity to ask questions about the experiment and no specific indication of the study was offered.

Following the first set of instructions, task one was presented. A rest period of approximately two minutes ensued wherein the child was offered some candies.

The auditory and visual anagrams of tasks two and three were randomly alternated, with the four problems within each task receiving random order of assignment as well. Subjects reported the solution of each specific problem orally. The fourth task was presented last in the series for all subjects.

Statistical Analysis

A 2 x 4 (Groups X Tasks) analysis of variance (Winer, 1962,

p. 302) with repeated measures on tasks was carried out for both of the dependent measures of amplitude and mean amplitude. The two levels for groups were normal and educable mentally retarded children, and the four levels for tasks were non-signal tones, auditory "ready" stimulus, visual "ready" stimulus, signal tones with an imagined button press response.

A separate 2 x 2 (Groups X Tasks) analysis of variance design with repeated measures was used with respect to the tonic response taken on the anagram tasks. This design was employed for both mean conductance change and for conductance change on the first anagram in each of the two series.

A chi-square test of independence of groups and rightness or wrongness of problem solution was also undertaken to determine whether or not normals gave more correct solutions than retardates to the anagram problems.

CHAPTER V

RESULTS AND DISCUSSION

This chapter presents the results of the analysis of the data and a discussion of the findings. It should be noted that low amplitude and conductance measures, are represented by high natural logarithm measures and vice versa, this inversion of values being a function of the transformation.

Hypothesis 1

One of the aims of this study was to compare the galvanic skin response of normal and educable mentally retarded children under varying stimulus conditions. It was hypothesized that normal children would show a greater initial (hypothesis 1.1) and mean (hypothesis 1.2) galvanic skin response amplitude than retardates.

The results of the 2 (group) by 4 (tasks) analysis of variance for initial amplitude and mean amplitude are reported in Tables 2 and 3, respectively. In the analysis of initial amplitude response, both main effects for tasks ($F = 6.790$, $df = 3/174$, $p < 0.01$) and an interaction between groups and tasks ($F = 5.842$, $df = 3/174$, $p < 0.01$) were found. Since the interaction was significant, a test for simple main effects of groups at the four task levels was computed.I In this analysis significant differences between groups were observed on task one ($F = 5.397$, $df = 3/174$, $p \leq .05$), and on task three ($F = 2.85$, $df = 3/174$, $p < .05$), with normal subjects showing a greater amplitude that the retardates on task one but a smaller amplitude on task three.

TABLE 2

GALVANIC SKIN RESPONSE AMPLITUDE TO NON-SIGNAL AND SIGNAL STIMULI, AND ANALYSIS OF VARIANCE

(a) Cell Means for Amplitude Measures to Non-Signal and Signal Stimuli

Groups	N	Tones (Non-Signal)	Auditory "Ready" Signal	Visual "Ready" Signal	Tones (Signal)
Educable Mentally Retarded	30	1.780	2.200	1.497	2.007
Normal	30	0.580	2.070	2.370	2.703

Summary Analysis of Variance

Source	df	Mean Square	F	P
Between Groups	59			
Groups (A)	1	0.216	0.024	0.878
Subjects Within Groups	58	9.096		
Within Subjects	180			
Tasks (B)	3	15.635	6.790	<0.001
A x B	3	13.453	5.842	<0.001
B x Subjects Within Groups	174	2.303		

TABLE 3

MEAN GALVANIC SKIN RESPONSE AMPLITUDE TO NON-SIGNAL AND SIGNAL STIMULI, AND ANALYSIS OF VARIANCE

(a) Cell Means for Mean Amplitude Measures to Non-Signal and Signal Stimuli

Groups	N	Tones (Non-Signal)	Auditory "Ready" Signal	Visual "Ready" Signal	Tones (Signal)
Educable Mentally Retarded	30	1.620	1.847	1.353	1.543
Normal	30	1.297	1.967	1.987	2.020

(b) Summary Analysis of Variance

Source	df	Mean Square	F	P
Between Groups	59			
Groups (A)	1	3.083	0.329	0.569
Subjects Within Groups	58	9.382		
Within Subjects	180			
Tasks (B)	3	2.172	1.016	0.387
A x B	3	2.709	1.267	0.287
B x Subjects Within Groups	174	2.139		

Hypothesis 1.1 was confirmed, then, only with respect to group differences on task one.

No significant effects were revealed on the analysis for mean amplitude of response. Neither a main effect for groups, nor an interaction between groups and tasks, was observed. Accordingly, hypothesis 1.2 is not substantiated in this study.

Cell means for groups, over all tasks, are plotted for the initial amplitude response in figure 1, and for mean amplitude response in figure 2. Comparison of group differences between the two figures illustrates the statistical finding, that group differences were stronger on the initial response than they were when the mean response to a series of stimuli was taken as the dependent measure. The normal children showed a significantly greater response on task one than did the retardates.

The retarded children however, showed a greater response on the signal stimuli than the normal children. Although not statistically significant, this comparison does reveal that differences in the orientation reaction between normal and retarded children is not attributable to a response deficit as far as the galvanic skin response component is concerned with signal stimuli. In fact, on the visual signal stimulus, the retarded subjects emitted a significantly greater initial response than the normal children. This result is interpreted in the light that the stimulus was more complex for the retarded subjects than for the normal subjects due to having to read the stimulus. Das and Bower (1970) suggest that the effectiveness with which normals

FIGURE 1:

GRAPHIC REPRESENTATION OF AMPLITUDE RESPONSE FOR GROUPS AND TASKS

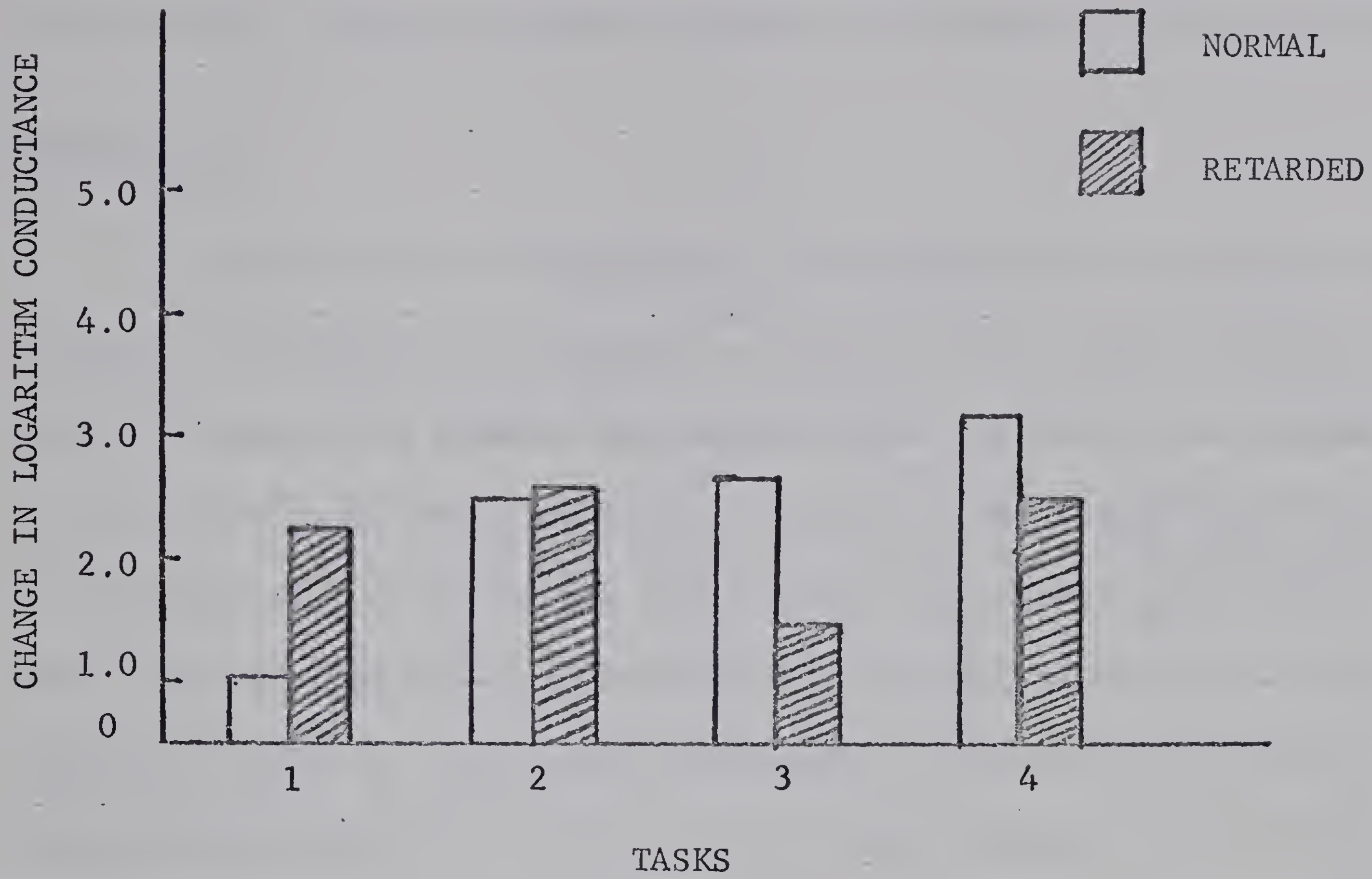
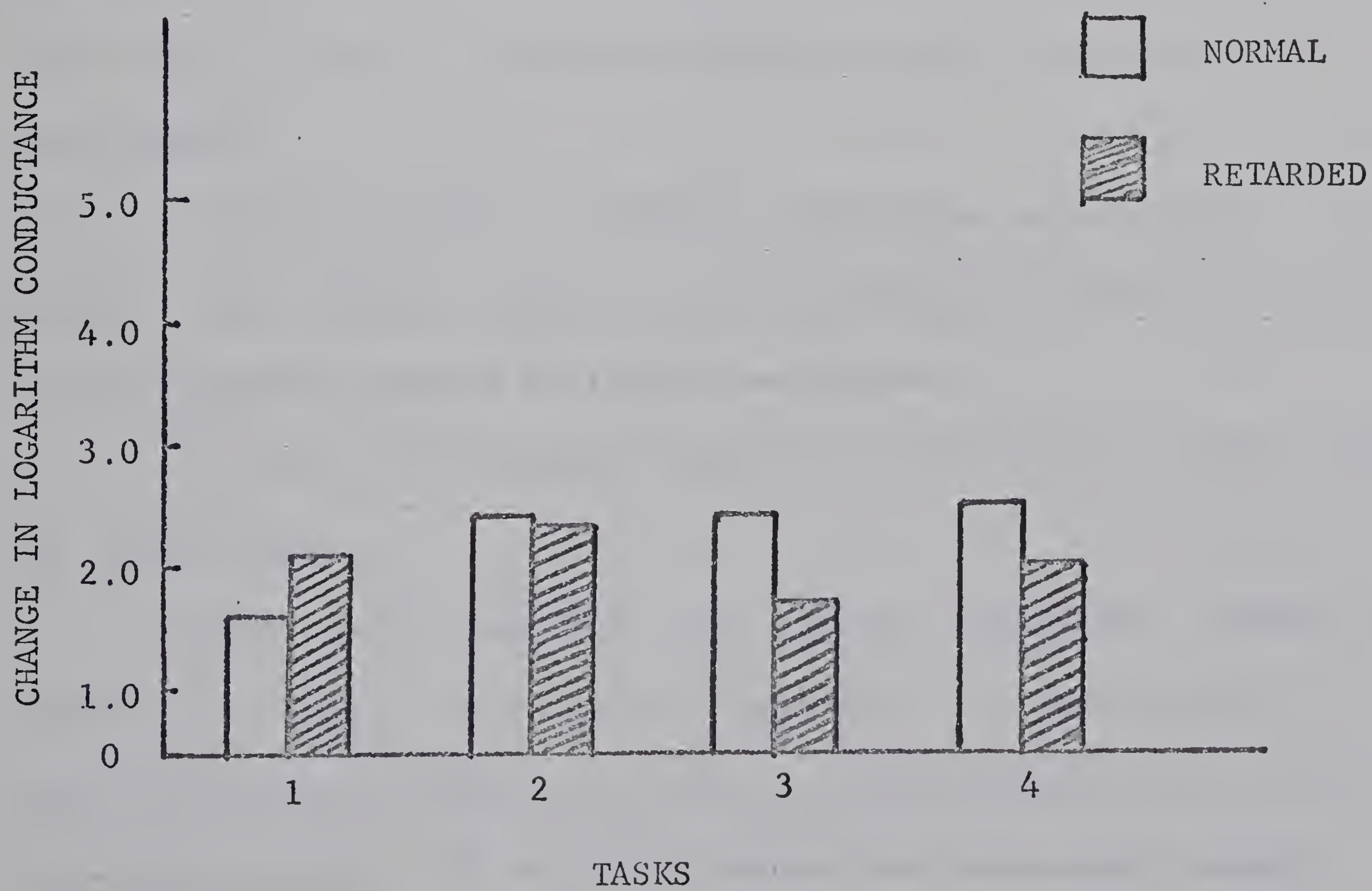


FIGURE 2:

GRAPHIC REPRESENTATION OF MEAN AMPLITUDE RESPONSE FOR GROUPS AND TASKS



and retardates compete a signal stimuli is an important area of study.

Hypothesis 2

A second aim of the study was to investigate the galvanic skin response of children to non-signal as compared with signal stimuli. Since an interaction between groups and tasks was found with respect to the initial amplitude, evidence relevant to the second hypothesis was explored through tests for simple main effects of tasks (Winer, 1962). The analysis for retardates is reported in Table 4, and for normals in Table 5. For initial amplitude, the tasks were found to differ significantly with the group of normal children ($F = 13.025$, $df = 3/87$, $p < 0.01$). A Newman Keuls test (Table 6) on individual comparisons revealed task one to be significantly different ($p < .05$) from task 2, 3, and 4. No other comparisons were significant for the normals.

No statistically significant differences among tasks 1, 2, 3, and 4 were observed with the educable mentally retarded subjects on the dependent measure of initial amplitude.

No effect of tasks was observed for the mean amplitude measure for either group.

Hypotheses 2.1 and 2.2, then, were not confirmed. Indeed, with respect to normals, the reverse of hypothesis 2.1 was observed, in that the stronger response was given to the non-signal rather than the signal stimuli. It cannot be argued that non-signal stimuli elicited a stronger response for normals than did signal stimuli,

TABLE 4

SIMPLE MAIN EFFECTS FOR TASKS, RETARDED GROUP

	Tones (Non-Signal)	Auditory "Ready" Signal	Visual "Ready" Signal	Tones (Signal)
Task Mean	1.780	2.200	1.497	2.007

Summary Analysis of Variance

Source	Mean Square	df	F	P
Between Subjects	8.871	29		
Within Subjects	2.589	90		
Treatments	2.750	3	1.065	0.360
Residual	2.583	87		

TABLE 5

SIMPLE MAIN EFFECTS FOR TASKS, NORMAL GROUP

	Tones (Non-Signal)	Auditory "Ready" Signal	Visual "Ready" Signal	Tones (Signal)
Task Mean	0.580	2.070	2.370	2.703

Summary Analysis of Variance

Source	Mean Square	df	F	P
Between Subjects	9.322	29		
Within Subjects	2.832	90		
Treatments	26.337	3	13.026	<0.000
Residual	2.022	87		

TABLE 6

TESTS ON MEANS USING
NEWMAN - KEULS PROCEDURE
FOR NORMAL GROUP

Tasks		b1 Tones (Non-Signal)	b2 Auditory (Ready Signal)	b3 Visual (Ready Signal)	b4 Tones (Signal)
Ordered Means		0.580	2.070	2.370	2.703
Differences	b1	-	1.490	1.790	2.123
Between	b2		-	0.300	0.633
Pairs	b3			-	0.333
$S_{\bar{B}} = .195$			R = 2	3	4
q.95 (r, 174)			2.770	3.310	3.630
$S_{\bar{B}}$ q.95 (r, 174)			0.540	0.645	0.711
Significant	b1	-	$p < .05$	$p < .05$	$p < .05$
Differences	b2		-	N.S.	N.S.
Between Pairs	b3			-	N.S.

because the non-signal stimulus was also the first one occurring before any signal stimulus. A stronger orientation generally occurs to the very first stimulus presented in the experiment.

Hypothesis 3

The third hypothesis was fundamentally exploratory since there was little direct experimental data reported in the literature which would substantiate the framing of a directional prediction of group differences on the conductance change measures as defined in the current study. Accordingly, in hypothesis 3.1 it was proposed that there would be no differences between normal and functionally retarded subjects on initial conductance change. Likewise, it was proposed in hypothesis 3.2 that there would not be group differences in mean conductance change.

A 2 (Groups) x 2 (Tasks) analysis of variance was carried out for initial conductance change taken to the first stimulus within the series and also for the mean conductance change for all stimuli within the series. The conductance change measures were used to represent the tonic response to auditory and visual anagram stimuli. The results are summarized in Tables 7 and 8. No significant effects were observed for the analysis of conductance change. A main effect for groups was found on the mean change of conductance, with the retarded subjects showing the larger response change (small logarithm change) on the dependent measure. For the analysis of mean change in conductance the task effect was short of reaching significance

TABLE 7

MEAN GALVANIC SKIN RESPONSE CONDUCTANCE CHANGE TO AUDITORY AND VISUAL ANAGRAMS, AND ANALYSIS OF VARIANCE

(a) Cell Means for Mean Conductance Change Measures to Auditory and Visual Anagrams

Groups	N	Auditory Anagrams	Visual Anagrams
Educable Mentally Retarded	30	0.193	0.480
Normal	30	2.410	1.003

(b) Summary Analysis of Variance

Source	df	Mean Square	F	P
Between Groups	59			
Groups (A)	1	102.674	6.713	0.012
Subjects Within Groups	58	15.296		
Within Subjects	60			
Tasks (B)	1	32.448	3.837	0.055
A x B	1	4.033	0.477	0.493
B x Subjects Within Groups	58	8.456		

TABLE 8

GALVANIC SKIN RESPONSE CONDUCTANCE CHANGE TO AUDITORY AND VISUAL ANAGRAMS, AND ANALYSIS OF VARIANCE

(a) Cell Means for Conductance Change Measures to Auditory and Visual Anagrams

Groups	N	Auditory Anagrams	Visual Anagrams
Educable Mentally Retarded	30	0.763	0.377
Normal	30	3.103	1.427

(b) Summary of Analysis of Variance

Source	df	Mean Square	F	P
Between Groups	59			
Groups (A)	1	86.190	2.682	0.107
Subjects Within Groups	58	32.134		
Within Subjects	60			
Tasks (B)	1	31.930	1.029	0.315
A x B	1	12.481	0.402	0.528
B x Subjects Within Groups	58	31.026		

($F = 3.837$, $df = 1/58$, $p < 0.055$) though the tendency was for stronger conductance change to be given for the visual anagrams. The groups by tasks interaction was well short of statistical significance. No other effects were significant.

The group differences which indicated a stronger mean conductance change for the retarded group is likely to be a function of the greater difficulty of the anagram problems for the retarded as compared with normal subjects. As a check upon this, a chi-square test of independence was conducted on the number of right responses occurring over the two groups (see Table 9). The significant chi-square observed in that table is associated with a greater frequency of wrong or "no answer" responses. Consequently, indirect support at least, is offered for the view that the greater retardate response might be a function of higher arousal initiated through failure or the threat of failure on the cognitive problems.

The near significant effect of tasks appears more difficult to interpret. The novelty effect of a visual stimulus being presented among predominately auditory stimuli, however, constitutes one possible explanation.

Since no direction was hypothesized it was necessary to indicate the relationship between the aspects of the orientation reaction which seems to be evident in the present study. The phasic response of the educable mentally retarded on the visual stimuli was found to be significantly different from that of the normal group. The tonic measure further differentiates these two groups, with the

TABLE 9

CHI-SQUARE TEST FOR INDEPENDENCE OF RIGHT AND WRONG RESPONSES TO ANAGRAM PROBLEMS

Auditory

	Right	Wrong	
Normal	103	17	120
Retarded	30	90	120
	133	107	240

$x^2 = 89.95$; df = 1; $p < .01$

Visual

	Right	Wrong	
Normal	112	8	120
Retarded	40	80	120
	152	88	240

$x^2 = 91.45$; df = 1; $p < .01$

retarded children showing a greater level of arousal on the auditory and visual signal stimuli. The Berlyne (1960) analogy seems to describe the relationship. The one is related to the other as the tide is related to the wave. It is suggested that a strong phasic orientation to auditory and visual signal stimuli is accompanied by high arousal. Germana and Chernault (1968) have shown that signal stimuli which produce multiphasic galvanic skin responses also produce responses which are presistent or tonic in nature. Since significant differences for groups were found to the initial visual signal stimulus and not to the initial auditory signal stimulus on the phasic orientation reaction, the results on the tonic measure are interpreted as being contradictory to a phasic-tonic response interdependence. The tonic response may be associated with other features such as response uncertainty. This alternative can be best applied to the results of the present study. Normal children may have shown less arousal due to correctness of response while retarded subjects required greater arousal due to response uncertainty.

General discussion of results

The presentation of non-signal stimuli and a number of signal stimuli, verbal and non-verbal, auditory and visual, provided for comparison of initial amplitude and mean amplitude galvanic skin response measures and also the tonic measures of initial and mean conductance change between normal and mentally retarded children. It can be observed from reaults that the two groups differ in the galvanic

skin response component of the orientation reaction under some of the experimental conditions.

Normal children exhibited a significantly greater response to the non-signal tone stimuli than the retardates. This result is consistent with the work of Berkson (1961), Fenz and McCabe (1971) and Luria (1963), who have proposed that normal children have a greater orientation reaction than retardates for non-signal stimuli. However, the results of the present investigation are not wholly supportive of the above mentioned authors due to the seemingly confounding of the task order. The non-signal task was always the first of the four experimental tasks presented. The educable mentally retarded children however, showed a significantly greater response to the "ready" signal on the visual anagram tasks than the normal subjects. It was proposed that the difficulty which the retardates experienced due to having to read the visual stimuli may account for the greater orientation reaction. It could also be argued, and perhaps more generally, that the stronger galvanic skin response of the retardates is evidence that the visual stimulus constituted a more intensely novel stimulus situation for these children than it did for the normal children.

With respect specifically to normal children, responses to non-signal stimuli were significantly different from the signal stimuli which were presented. No significant differences were found among the signal stimuli themselves. It would appear, then, that normal children respond to non-verbal or verbal, visual or auditory,

signal stimuli in much the same way. The possibility that normal children were habituating to the experimental conditions as well as the tasks must also be considered.

A weakness in the design of the study lies in the fact that task order was not randomized. Task one had to precede task four in the design, but tasks two and three need not have separated tasks one and four consistently. An improvement in design could be achieved by randomizing the sequence of tasks 2, 3 and 4. The stronger responses recorded for non-signal stimuli for normal children might be a function of task order rather than the signal and non-signal conditions themselves.

With specific regard to the retarded children no significant response differences were observed among stimulus conditions, whether the conditions be signal or non-signal, auditory or visual, verbal or non-verbal. The retarded subjects maintained a relatively equal response amplitude for all task conditions.

Differences in the mean tonic orientation reaction of normal and educable mentally retarded children were observed with the auditory and visual anagrams. A greater level of arousal was found for the retardates as indicated by a smaller mean logarithm conductance change. The general arousal concept as proposed by Berlyne (1967) and Sokolov (1966) may be applicable here. The increase in arousal may be functionally dependent upon the characteristics of the perceived stimulus input, that possibly being greater response uncertainty for retardates in the present study. Further support of a general arousal concept as cited by Taylor and Epstein (1967) is offered.

That the phasic orientation response of normal and educable mentally retarded children did not significantly differ on task 4 is contradictory to the observations of Luria and Vinogradova (1963). The latter had observed differences in orientation between child oligophrenics and normals, where signal stimuli were provided. An explanation for seemingly contradictory findings may lie in the nature of the populations from which the samples were drawn. It is likely that the Luria sample would have included younger children and those who were organically involved than did the sample used in the current study.

The present study utilized educable mentally retarded children within the regular school system. Karrer (1966) states that the literature dealing with the autonomic activity of functionally retarded children is quite meager, as there has been a tendency to combine such children with other classes of mental retardates.

Nevertheless, the high arousal level of the retardates on tasks two and three should be regarded as a contributing factor to the strong orientation reaction that they elicited on task four. Once again task order may be viewed as confounding the results presented.

CHAPTER VI

SUMMARY, LIMITATIONS, IMPLICATIONS

Summary

The present study was an attempt to investigate possible differences in the orienting responses of normal and functionally retarded children. The galvanic skin response, a component of the orientation reaction, was observed with the dependent variables being both initial and mean amplitude to represent the phasic aspect and initial conductance and mean conductance change to represent the tonic aspect of the orienting response. The subjects comprised a sample of 30 students from regular classrooms, normals, and 30 students from opportunity classes, functionally retarded, within the Edmonton Public School System.

In the first part of the study non-signal stimuli (tones), and a range of signal stimuli (auditory and visual, verbal and non-verbal stimuli), were manipulated as the independent variables. In the second part of the study normal and retarded groups were compared on the so-called tonic response of the orientation reaction. The stimuli for this part of the study was comprised of auditorily and visually presented three-letter anagrams.

In measuring the phasic response, galvanic skin responses were measured as the maximum change in logarithm conductance between the average conductance level recorded over the three seconds preceding stimulus onset, and the peak level recorded within a one

to three second period following stimulus onset. The tonic response was represented by the maximum change in logarithm conductance observed between the average conductance level recorded over the three second period preceding stimulus onset, and the average conductance level recorded over the three second period immediately preceding problem termination. An analysis of variance repeated measures design was employed to investigate the effects of group classification and stimulus characteristics upon the various dependent galvanic skin response measures. A chi-square was employed to investigate the effectiveness with which each subgroup competed on the anagram task.

The analysis of the data revealed some response differences associated with groups and tasks, although not all differences were in the predicted directions. Examination of a significant interaction between groups and tasks on the measure of response amplitude to the first stimulus within each series revealed that the normal subjects gave a greater response to the non-signal stimulus, this being the first task condition presented in the experiment. The children had greater response amplitude to the visual than to the auditory signal stimuli, these tasks being randomly alternated between the second and the third task positions.

On the conductance change measures, which were assumed to represent a possible tonic response to the relatively more complex stimuli of the anagram problems, no statistically significant effects were observed on the response to the first stimulus within each of the two series, but a main effect for groups was observed on the mean

conductance change measure, with the retardates showing a greater response magnitude.

Group differences observed on the response to non-signal stimuli were consistent with those commonly reported in the literature (Berkson, 1961; Fenz & McCabe, 1971; Luria, 1963) but not entirely supportive due to confounding task order. With respect to the phasic response to visual signal stimuli, the stronger response was observed among the functionally retarded children. This reversal in relative response amplitude between groups was interpreted in terms of various situational determinants which were thought to apply within the study, the important point being that the galvanic skin response magnitude is not so much a function of group classification, or of stimulus specific effects, alone. Rather, the galvanic skin response, and the orienting response which it is believed to represent, is sensitive to a subject's <u>perception</u>, (his set and expectation), relevant to a specific stimulus or stimulus situation. An interpretation such as this, which emphasises the interaction between person and task characteristics, is consistent with some of the propositions of Lacey (1967) and Taylor & Epstein (1967) who have argued that arousal, admittedly a more general construct than that of the orienting response, might have more multidimensional properties than is often assumed. The results of the chi-square were interpreted to suggest that response uncertainty might be one such property since the retardates who revealed significantly higher arousal, also exhibited a significantly greater number of wrong responses.

It was concluded from the analysis of task (stimulus) effects that signal stimuli do not in themselves have a differential effect upon orienting responses as a function of sensory mode, at least with respect to auditory and visual modalities, or symbolic characteristics (verbal or non-verbal). Furthermore, it was concluded that functionally retarded children do not manifest the consistent deficit in the functioning of orienting responses that is commonly attributed to organically involved mentally retarded children, at least, insofar as the galvanic skin response is concerned.

Limitations

During the course of the investigation certain limitations have been perceived which should be brought to the reader's attention. Although it is difficult to control for all variables, the study did attempt to minimize such interventions as extraneous noise, and peripheral stimulation. The extent to which these factors affected the investigation is undetermined. The non-signal stimuli were defined as neutral stimuli but any associative process immediately succeeding the presentation of the tone is likewise undetermined.

Probably the most serious limitation is the confounding of task order within the design. The stronger response of normals to non-signal than to signal stimuli might be an artifactual product of such confounding. Certainly there was indirect evidence from the graphical representation of cell means for amplitude that some habituation across tasks might be characteristic of the normals

though it was not evidenced in the responses of the functionally retarded children. Such confounding, however, has more relevance for the interpretation of task effects than it does for the central concern of group differences. However one could control for the confounding variable by providing a visual non-signal stimulus to allow randomization of the four tasks or simply to allow an adequate time interval to elapse on randomly assigning the present stimulus tasks.

Implications

There is a need for an investigation which controls for the confounding of task order. Such a study may reveal information of vital importance to the results found herein.

There appears to be considerable room for further investigation of arousal, or perhaps the tonic response. The group differences observed on conductance change, and the association noted with right and wrong responses to the anagrams, may be interpreted as evidence that similar situations have quite different effects upon the arousal, and no doubt autonomic state, of the different learners to be found within any classroom. The investigation of other variables such as the ability to perceive stimulus change, and reinforcement following the conditioned response to signal stimuli, should be made to determine their effect upon the arousal reaction of children at large.

REFERENCES

REFERENCES

Berkson, G. Responsiveness of the mentally deficient. American Journal of Mental Deficiency, 1961, 66, 277-286.

Berlyne, D. E. Conflict arousal and curiosity. New York: McGraw-Hill, 1960.

Berlyne, D. E. Arousal and reinforcement. In Nebraska Symposium on Motivation, David Levine (Ed.), University of Nebraska Press, 1967.

Berlyne, D. E. Conflict and the Orientation Reaction Journal of Experimental Psychology, 1961, 62, 476-483.

Berlyne, D. E., Craw, M. A., Salapatek, P. H. and Lewis, J. L. Novelty, complexity, incongruity, extrinsic motivation, and the GSR Journal of Experimental Psychology, 1963, 66, 560-567.

Berlyne, D. E. & McDonnell, P. Effects of stimulus complexity and incongruity on duration of EEG desynchronization. Electroencephalography & Clinical Neurophysiology, 1965, 18, 156-161.

Bernstein, A. S. To what does the orienting response respond? Psychophysiology, 1969, 6, 338-350.

Claussen, Johs, & Karrer, Rathe. Orienting response-frequency of occurrence and relationship to other autonomic variables. American Journal of Mental Deficiency, 1968, 73, 455-464.

Cowles, M. P. Skin conductance and reaction time with and without knowledge of results. Psychonomic Science, 1970, 20, 117-119.

Darrow, C. W. The rationale for treating the change in galvanic skin response as a change in conductance. Psychophysiology, 1964, 4, 31-39.

Darrow, C. W. Problems in the use of the galvanic skin response (GSR as an index of cerebral function: implications of the latent period). Psychophysiology, 1967, 3, 389-396.

Darrow, C. W., Gullickson, G. R. The periferal mechanism of the galvanic skin response. Psychophysiology, 1970, 6, 597-600.

Das, J. P. Changes in stroop-test responses as a function of mental age. British Journal of Social and Clinical Psychology, 1970, 9, 68-73.

Das, J. P. & Bower, A. C. Orienting responses of mentally retarded and normal subjects to word-signals. British Journal of Psychology, 1971, 62, 89-96.

Denny, R. M. A theoretical analysis and its application to training the mentally retarded. In Ellis, N. R. (Ed.), International Review of Research in Mental Retardation, Vol. 2, New York: Academic Press, 1966, 1-27.

Fenz, W. D. & McCabe, M. W. Habituation of the GSR to tones in retarded children and nonretarded subjects. American Journal of Mental Deficiency, 1971, 75, 470-473.

Germana, J. & Chernault, G. Patterns of galvanic skin responses to signal and non-signal stimuli. Psychophysiology, 5, 1968, 284-292.

Jeffrey, W. E. The orienting reflex and attention in cognitive development. Psychological Review, 1968, 75, 323-334.

Kaplan, B. E. Psychophysiological and cognitive development in children: The relationship of skin conductance and heart rate to word associations and task requirements. Psychophysiology, 1970, 7, 18-26.

Karrer, R. Autonomic nervous system function and behavior: A review of experimental studies with mental defectives. In Ellis, N. R. (Ed.), International review of research in mental retardation. Vol. 2, New York: Academic Press, 1966, pp. 57-83.

Karrer, R. & Claussen,J. A comparison of mentally deficient and normal individuals upon four dimensions of autonomic activity. Journal of Mental Deficiency Research, 1964, 8, 149-163.

Korn, J. H. & Moyer, K. E. Effects of set and sex on the electrodermal orienting response. Psychophysiology, 1968, 4, 453-459.

Lacey, S. I. Somatic response patterning and stress: Some revisions of activation theory. In M. H. Appley and R. Turnbull (Eds.), Psychological stress: Some issues in research. New York: Appleton-Century-Crofts, 1967.

Leavy, A. & Geer, J. H. The effect of low levels of stimulus intensity upon the orienting response. Psychonomic Science, 1967, 9, 105-106.

Lobb, H. Frequency vs magnitude of GSR in comparisons of retarded and nonretarded groups. American Journal of Mental Deficiency, 1970, 75, 336-340.

Luria, A. R. The mentally retarded child. Oxford: Pergamon, 1963.

Luria, A. R., & Vinogradova, O. S. Peculiarities of the orientation reflexes in child-oligophrenics. In Luria, A. R. (Ed.), The mentally retarded child. New York, Pergamon Press, 1963.

Lykken, D. T. Properties of electrodes used in electrodermal measurement. Journal of Comparative and Physiological Psychology, 1959, 52, 629-634.

Lynn, R. Attention, arousal and the orientation reaction. Longon: Pergamon Press, 1966.

Maltzman, I., & Raskin, D. C. Effects of individual differences in the orienting reflex on conditioning and complex processes. Journal of Experimental Research in Personality, 1965, 1, 1-16.

Martin, I. The measurement of skin resistance. Bulletin of British Psychological Society, 1964, 17, 13-17.

McCubbin, R. J., & Katkin, E. S. Magnitude of the orienting response as a function of degree of change in stimulation. Psychophysiology, 1968, 4, 504-505.

Montagu, S. D. & Coles, E. M. Mechanism and measurement of the galvanic skin response. Psychological Bulletin, 65, 1966, 261-277.

O'Gorman, J. G., Mangan, G. L., & Gowen, J. A. Selective habituation of galvanic skin response component of the OR to an auditory stimulus. Psychophysiology, 1970, 6, 716-721.

Pilgram, D. L., Miller, F. D., & Cobb, H. V. GSR strength and habituation in normal and nonorganic mentally retarded children. American Journal of Mental Deficiency, 1970, 74, 27-31.

Pribram, K. H. The new neurology and the biology of emotions: A structural approach. American Psychologist, 1967, 22, 830-838.

Reese, H. W., Lipset, L. P. Experimental child psychology. New York: Academic Press, 1970.

Sokolov, E. N. Neuronal models and the orienting reflex. In M. A. Brazier (Ed.), The central nervous system and behavior. New York: J. Macy, 1960.

Sokolov, E. N. Perception and the conditioned reflex. Oxford: Pergamon Press, 1963.

Sokolov, E. N. Orienting reflex as information regulator. In A. Leontiev, A. Luria, & A. Smirnov (Eds.), Psychological research in the U.S.S.R. Vol. 1, Moscow: Progress Publishers, 1966, pp. 334-360.

Stern, J. A. Toward a developmental psychophysiology: my look into the crystal ball. Psychophysiology, 1968, 4, 403-420.

Taylor, S. P. and Epstein, S. The measurement of autonomic arousal. Psychosomatic Medicine, 1967, 29, 514-525.

Winer, B. J. Statistical principles in experimental design. New York: McGraw-Hill, 1962.

Wolfensberger, W., & O'Connor, N. Stimulus intensity and duration effects on EEG and GSR responses of normals and retardates. American Journal of Mental Deficiency, 1965, 70, 21-37.

Woodworth, R. S. Experimental psychology. New York: Henry Holt and Company, 1954.

Zeaman, D., & House, B. J. The role of attention in retardate discrimination learning. In Ellis, N. R. (Ed.), Handbook of mental deficiency. New York, McGraw-Hill, 1963.

APPENDIX A

Task Instructions Given to Subjects

TASK INSTRUCTIONS GIVEN TO SUBJECTS

Non-signal (tone stimulus)

"Now listen carefully and I'll tell you what we are going to do. Ready now. Just look straight ahead and keep looking inside the black circle. I want you to sit just as still as you can for seven minutes: I shall tell you as soon as you can stop. Have you got that? Sit as still as can be, and keep your eyes looking inside the black circle. Don't let your eyes look outside the circle at all. Right. We'll start now."

Auditory Anagrams

Prior to the instructions, each subject was given two or three examples to demonstrate the task.

"Now we are going to play that word game again, but I want you to sit very still this time while we play it. I am going to tell you the mixed-up letters over these earphones, and you must listen very carefully to hear them. Then see if you can make a word you know out of them. Close your eyes as soon as you have the word. Did you understand the game? Let me tell you again. Sit very still. Listen carefully for the mixed-up letters. Try to make a word you know out of them. Then close your eyes as soon as you have the word. Right. Let's try it."

Visual Anagrams

Prior to the instructions, each subject was given two or three

examples to demonstrate the task.

"Now we are going to play that word game again, but I want you to sit very still this time while we play it. I am going to put the mixed-up letters on the screen, and you see if you can make a word you know out of them. Try as hard as you can, and as soon as you have found the word, close your eyes. Got the idea? Sit very still. Look at the mixed-up letters. Make a word you know out of them, and as soon as you have got the word, close your eyes. Let's start now."

Signal (tone stimulus)

During the instructions for this task each subject was shown a button mounted on a piece of wood and instructed to press it several times.

"What I want you to do now is just to sit still, look straight ahead inside the black circle, and listen for some little "beep" sounds that will be coming over the earphones. When you hear one of these sounds, I want you to pretend you are pressing a button like this one, but I don't want you to move your hand or fingers at all. I'll tell you again. Just sit still in your chair, look straight ahead, and pretend you are pressing this button whenever you hear the "beep" sound.

APPENDIX B

Anagram Problems, Auditory and Visual

ANAGRAM PROBLEMS

Problems Given to Subjects

Auditory Problems

1. a--y--w (way)
2. o--c--w (cow)
3. e--g--b (beg)
4. t--l--e (let)

Visual Problems

1. n ^{e} m (men)
2. u ^{p} t (put)
3. r ^{b} a (bar)
4. n ^{e} p (pen)